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RESEARCH PAPER

# Social and ecological issues for private native forestry in north-eastern New South Wales, Australia

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**Abstract** Forests in north-eastern New South Wales have often been the focus of controversy. The tension between production and preservation continues and hampers current negotiations for a code of practice for private native forestry. The structure of many private forests reflects past mismanagement, and silvicultural intervention would benefit both conservation and production objectives, but such intervention is rarely financially viable. This paper sets out the economic and ecological basis for private native forestry. Both the timber industry and nature-based tourism are major contributors to the local economy, and both rely in part on private native forests. Draft regulations currently under negotiation do not offer incentives for improved private forest management.

**Keywords** Harvesting · Silviculture · Non-industrial private forest · Environmental services

## Introduction

Forests in north-eastern New South Wales (NSW, Australia) have stimulated controversy and innovation in natural resource management for more than a century. In 1837, uncontrolled cedar-getting in the region prompted the introduction of the first attempt to regulate the timber trade. The Clarence timber reserves of the 1870s were amongst the first such reserves in Australia (Stubbs 1999). The dedication of the Mt Warning National Park in 1929 was the first of many changes in tenure from State Forest to National Park in NSW. Rainforests have featured prominently, with the establishment in 1965 of an innovative series of experiments to inform silviculture (Smith et al. 2005), and the first mass public protests against timber harvesting at Terania Creek in 1979 (Turvey 2006). These tensions between

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production and conservation continue, and the current focus of many stakeholders is on the management of private native forests (Nichols 2007).

Timber has been harvested from forests in the region since the early 1800s, but demand for timber from private forests has increased since the Regional Forest Agreements (Lane 1999; Ananda 2004) which added 380,000 ha to the National Park estate overnight (Smith 1999; Clune 1999), and substantially reduced the supply of public sawlogs. Production forests continue to provide a wide range of environmental services, and there is an expectation amongst some stakeholders that biodiversity conservation should take precedence over other land uses (Prest 2004; Flint et al. 2004). This expectation created an impasse in the introduction of the draft Code of Practice for Private Native Forests (Nichols 2007). This paper establishes the context and explains the background to that controversy. We briefly describe the extent and types of privately owned native forest in northeast NSW and their importance as economic resources and wildlife habitat. Typical silvicultural practices and their implications for future yield and habitat value are discussed. We suggest that policies to encourage restorative silviculture in structurally degraded forests are needed, and that regulation of harvesting practices will not achieve that outcome. We seek to stimulate debate about the application of market-based policy instruments for improved outcomes from managed private native forestry.

## Geographical and Social Context

The region discussed in this paper encompasses 4 M ha in north–east New South Wales, near the eastern-most point of Australia and centred on 29° S 153° E. The area is bounded by the coast, and a low mountain range (1,000–1,500 m elevation) which rises abruptly 100–120 km inland from the coast. The coastal plain features undulating hills up to 500 m elevation. The climate is subtropical with mean annual rainfall 900–2,000 mm, half of which falls during January to April. Summer is hot and humid, mild winter frosts are common in the inland valleys, and regular fires occur during the hot dry spring months.

About half of the non-urban land area in the region is forested, half of which is privately owned, with the remaining public forest being approximately evenly split between production and conservation tenures. Much of the public State Forests are managed for nature conservation or water supply, and no timber harvesting is conducted in these areas (Forests NSW 2005). There are 1.0 M ha of private native forest, partly managed for timber production, which make a substantial contribution to the timber industry and regional economy (NRPF 2005). The timber industry directly employs more than 5,200 people and contributes over $130 M to the regional economy in wages alone. With the flow-on effect to service industries, total employment directly attributable to the industry is more 9,000 people with a contribution of $240 M in wages (NRPF 2007).

The area was formerly dominated by timber and dairying, but has become more diverse in the past three decades. Low land prices following decline of the dairying industry, coupled with the Aquarius Festival at Nimbin in 1973, brought many ‘alternative lifestylers’ (Hannan 2002). More recently, many professionals have

moved to the region, often a lifestyle choice associated with retirement to a rural or coastal residence (Essex and Brown 1997; Gibson et al. 2005). These demographics mean that the region is home to many people who are concerned for the environment, and who are able to offer financial or voluntary support to environmental non-government organizations (NGOs). The resulting diversity in the community leads to divergent views about land-use policy.

## Forest Types and Fauna in Northern NSW

The private forest estate is predominately sclerophyll forest, dominated by *Eucalyptus* species and often accompanied by related genera including *Corymbia, Lophostemon* and *Syncarpia* occurring as co-dominants (Baur 2001). These forests are commonly described as dry or wet sclerophyll: dry sclerophyll types have a grassy or low open sclerophyllous shrub understorey, whereas wet sclerophyll types usually have dense mesophyll shrubs or a sub-canopy layer of shade tolerant small trees, or tussock grasses and ferns. A small number of wet sclerophyll species, mainly on more fertile sites with infrequent fire, occur naturally as even-aged monospecific stands regenerating *en masse* by seed after fire or soil disturbance. Most of the forests are uneven-aged mixed species stands on poorer sites where natural fire frequencies range from 3 to 15 years and the groundcover is sparse or absent. Within such stands it is common to find a wide range tree sizes (from saplings to large veterans >100 cm dbh) in close proximity, with most post-disturbance regrowth arising from lignotuberous advance growth (Florence 1996; Baur 2001).

Keenan and Ryan (2006) estimated that over 20% of the private forest estate in NSW is ‘old-growth’, with an overstorey dominated by large veteran trees and with few signs of past disturbance (although this estimate is contested by long-term local residents, who suggest that such ‘old growth’ may constitute only 10% of the private estate). Much of the old-growth (57% by area according to Keenan and Ryan 2006) is in formal and informal conservation reserves. However, the majority of the private forest estate has been logged, or is regrowth on land previously cleared for agriculture. Anecdotal and photographic evidence suggest that substantial forest regrowth occurred during the war years (1939–45) and following decline in the dairy industry. In many areas, forest cover is greater now than it was in the early-mid 1900s.

The subtropical sclerophyll forests provide habitat for a wide range of native fauna, including ground and arboreal marsupials, bats, reptiles and many species of birds. The region has particularly high fauna species richness (Lunney 2004) with representatives of both temperate and tropical zones. Top-of-food-chain predators include large dasyurids (carnivorous marsupials of the family Dasyuridae) and forest owls. Owls are commonly recorded in logged landscapes, but have home ranges centred on undisturbed riparian areas (Kavanagh 2002). Although no animal species occur exclusively in private forests, the private estate remains an important element of the habitat matrix, providing connectivity between non-contiguous reserves and public forests as well as extensive areas of habitat in their own right.

## Owner Intent and Forest Structure

A survey of 94 private native forest owners in 2003 revealed that the majority have harvested timber during the past decade (Table 1, summarised from Jay 2006a). Most respondents who harvested logs in the last 10 years expressed an intention to harvest again within the next 5 years (not necessarily from the same area). Most of those who intended to harvest within the next 5 years had recently harvested at least 250 $m^3$ of logs. About a third of the non-harvesting group intended to harvest in the next 5 years. These findings correspond with previous work (NNFS 1999, 12% response rate from 900 surveyed landowners) that about half of all landowners are engaged in forestry, either currently or with short-term future intent.

Jay (2006a) conducted an inventory (totalling 103 plots on 32 landholdings) of the private forest estate, reported in Table 1, and revealed that the modal basal area in these forests was 20 $m^2$/ha (8–48 $m^2$/ha), typically with a large proportion of small unmerchantable trees of poor vigour. Few sampled properties carried stands with large numbers of big trees, supporting the notion that 'old growth' forests are scarce in the region.

## Silvicultural and Harvesting Practices

Most eucalypts are light-demanding and intolerant of competition, and will stagnate if overtopped by large individuals or when stand basal area or stocking densities are high. In the sapling or lignotuber stage, some species are relatively persistent but

**Table 1** Private native forest landowner history and intent (Jay 2006a)

| Harvest history and intention | Parcels | Land owners | Land parcel size | | | Past 5 years harvest volume | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | <50 ha | 50–250 ha | >250 ha | 0 $m^3$ | <250 $m^3$ | 250–500 $m^3$ | >500 $m^3$ |
| Harvest in last 10 years[a] | 64 | 49 | | | | | | | |
| Harvest intent 5 years | | 41 | 6 | 13 | 22 | 6 | 11 | 10 | 13 |
| ZERO harvest intent 5 years | | 8 | 3 | 3 | 2 | 5 | 2 | 0 | 1 |
| ZERO Harvest in last 10 years | 50 | 45 | | | | | | | |
| Harvest intent 5 years | | 14 | 4 | 6 | 4 | n/a | | | |
| ZERO harvest intent 5 years | | 31 | 14 | 10 | 7 | | | | |

[a] Harvesting refers specifically to commercial logging, which was specified in the text of the questionnaire sheet. Landowners were asked to infer previous owners activities if they had owned the parcel for less than 10 years

grow very slowly. Other species maintain higher rates of diameter growth in the short term but stagnate and suffer high mortality, e.g. flooded gum (*Eucalyptus .grandis*( and blackbutt (*E. pilularis*). Continued vigorous growth for most species thus requires initial stand opening and regular thinning (Attiwill 1994; Bauhus 1999). Once suppressed, many eucalypts and spotted gum (*Corymbia maculata*) have little chance of regaining vigour even if the overwood is subsequently removed (Florence 1996).

The most common harvesting practice in these uneven-aged mixed-species stands is selection logging (Vanclay 1989) which typically removes 40–60% of the pre-harvest basal area, or more rarely, small group selection which creates canopy openings by removal of all trees in an area of 0.2–0.5 ha (Florence 1996). Most operations employ chainsaw felling with extraction by tractor or skidder. Harvests occur at intermittent intervals of 10–20 years, and typically about 10–50% of gross standing volume is removed during harvesting of 20–200 ha (yielding commercial volumes of 10–50 $m^3$/ha).

Potential productivity of these forests tends to be 5–30 $m^3$/ha/yr, but the actual production of useable solid wood is generally much less, often as little as 0.5–1 $m^3$/ha/yr mean annual increment (NNFS 2002). One reason for this low productivity is that there is no local market for smallwood or low grade logs as fibre or biomass, and the growth or value increase in larger trees as a response to thinning does not cover the cost of culling at any reasonable discount rate. Most harvest operations are therefore a simple extraction of commercial material only, i.e. 'high-grading' of larger sizes and straight clean boles. Thinning from below (removing small trees while retaining larger ones) and 'timber stand improvement' (removal of unmerchantable trees and unthrifty overwood to release existing saplings) are rarely practised. Over time the accumulation of suppressed, defective or non-commercial trees may be as much as 85% of the total stocking on large areas (Combe et al. 1998) and these stems occupy the potential growing space of better trees.

Physical disturbance of mineral soil (i.e. removal of any organic layer), and substantial canopy opening (at least 70%) may be necessary to secure productive regrowth in wet sclerophyll forests (Nicholson 1999). Single tree selection and small gaps do not create sufficient disturbance and usually lead to an understorey dominated by vines and short-lived rainforest pioneer species. Florence (1996) described how 'radical' treatments led to greater volume increment than did 'conservative' treatments in similar forests at Pine Creek, NSW. Large eucalypt trees can suppress regeneration over an area extending 2–6 times the crown radius. Basset and White (2001) found that suppression of young regrowth may extend 70 m from the edge of a logged stand, and that regrowth volume and height growth losses can be in the order of 15–50% compared to clearfelling, when 10–30% basal area is retained in stands with an initial basal area of 40 $m^2$/ha. They observed greatest impacts on lower rainfall sites and where retention comprised scattered large trees. Retaining five large trees (of at least 100 cm dbh) per hectare may result in growth losses of 10–40% relative to stands with no overwood (Bassett and White 2001).

## Wildlife Habitat and Forest Management History

Since habitat (shelter, food, nesting) for most terrestrial forest fauna is ultimately dependent on the vegetation, there have been an increasing number of efforts directed at linking biodiversity with vegetation structure, using various ways of summarising structure and complexity in an index or score (McElhinny et al. 2005; Lindenmayer et al. 2006). Jay (2006b) used four of these scoring methods and supporting wildlife surveys to assess habitat value of 21 sites on four properties carrying spotted gum forest in north–east NSW. The indexes measure factors such as canopy cover, abundance of large or hollow-bearing trees, plant life-form and species richness, regeneration, coarse woody debris, weed density, and ground and litter cover. Points are awarded on the basis of how closely these match to ‘benchmark’ states (long-undisturbed mature stands). On each property, up to six sites were selected to represent a range of past history and current stand structures (Table 2). One of the properties (Whiporie) had not been logged, grazed or burnt for 15 years, but all others were actively used for cattle grazing and timber production.

Most sites scored 70–90 out of a possible 100 with three of the scoring methods. There was no obvious relationship between the scores, the richness or abundance of broad faunal groups, objective or subjective (descriptive) measures of forest stand structure and silvicultural condition, or past management history. Two possible interpretations of the lack of differences in habitat value index scores for these sites are (i) that private native forestry harvest operations are not having a substantial impact on general forest habitat values, or (ii) the index scores do not have enough discriminatory power for detecting important differences in habitat value. The latter may arise from counteracting effects of harvest versus no harvest on components in the index (e.g. fallen log abundance and overstorey cover), and the absence of some site-specific variables (winter-flowering nectar species, dead trees) or landscape-scale diversity variables.

The lack of correlation between site scores and fauna, and between site scores, nominal structure and management history, suggests that biodiversity may be maintained simply by maintaining forest cover and structural diversity. Provided that specific habitat elements (e.g. hollow-bearing trees, nectar-producing understorey, rotting logs, mistletoe) are maintained for fauna species which use these resources and are known to be present, production forestry is unlikely to reduce site-level biodiversity greatly in these privately-owned spotted gum forests. These findings are similar to those of Braithwaite (2004), who concluded that permanent clearing, not current forestry practices per se, was likely to be the most significant factor threatening the viability of native fauna in Australia.

## Silviculture to Enhance Forest Values

Silviculture is essentially about decision-making, and concerns the timing, intensity and manner of manipulating the structure and floristic composition of a forest stand to achieve the objectives of the owner. Integrating the multiple factors involved in a silvicultural decision can be a challenging task for landowners. Florence

**Table 2** Species observed in 21 case studies on properties carrying privately owned spotted gum forests

| Number of sites and species observed by faunal groups | Property locality | | | | Structure/management category[a] | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Nymbodia | Drake | Rappville | Whiporie | BIGO | DISC | HVST | LOGG | REGR | RIPN | Total[b] |
| Replicates/Sites | 5 | 6 | 6 | 4 | 4 | 2 | 4 | 3 | 4 | 4 | 21 |
| Amphibians | 1 | 2 | 7 | 0 | 1 | 3 | 4 | 2 | 5 | 2 | 10 |
| Reptiles | 4 | 8 | 3 | 1 | 3 | 6 | 1 | 6 | 2 | 2 | 12 |
| Birds | 21 | 22 | 42 | 21 | 21 | 19 | 26 | 21 | 28 | 19 | 72 |
| Mammals | 5 | 6 | 5 | 5 | 3 | 4 | 8 | 2 | 4 | 6 | 14 |
| Total species[b] | 31 | 38 | 57 | 27 | 28 | 32 | 39 | 31 | 39 | 29 | 108 |

[a] BIGO, Big old trees prevalent; DISC, Disconnected block; HVST, Ready to harvest; LOGG, Recently logged; REGR, Predominantly regrowth; RIPN, Near riparian zone

[b] Fauna species totals are not additive for sites or structures because many species occurred at more than one location

(1977, 1996) described seven groups of these decision factors under headings of ecological factors, existing products, market factors, condition of existing growing stock, economic and financial factors, technical efficiency, and environmental factors, to which could be added an eighth, regulatory factor.

Native eucalypt forests are long-lived complex dynamic biological systems. In order to deal with the poor stand conditions that are the legacy of high-grading and determine whether forestry is a financially viable option under various regulatory constraints, a landholder needs a forecasting system to indicate what a patch of forest might yield now, and what it might look like in future after some silvicultural intervention. While much has been written about the ecological and financial aspects of managing native forests, it is often difficult to apply this general information in a specific setting and then fully appreciate all the implications over the medium to long term. This is especially so when forests involve many species and sizes. Although a qualitative appreciation of the options is relatively easy to convey, quantitative analyses require simulation models (Vanclay 1994). Such models allows objective examination of questions such as: ‘What is the optimum level of selective harvesting?’; ‘Which stand fractions should be removed?’; and ‘When is the best time to do this?’. A well-calibrated model allows ‘virtual forestry’ experiments to be undertaken at minimal cost, risk and time, and thus allows the owner to explore the implications of various harvest options in stands with widely differing structures and species in a range of market environments.

Jay (2006a) used a growth model (EUCAMIX) to simulate future stand structures and timber yields of 21 sites (Table 2) under various harvesting strategies, and showed that substantial differences in forest structure and productivity are likely to arise as a result of choice of silvicultural treatment. EUCAMIX is a stochastic distance-independent tree-list model (Vanclay 1994) designed to simulate many of the silvicultural options used in uneven-aged mixed-species eucalypt forests. The model forecasted growth for 32 years based on the biophysical attributes of the site (climate, soil, topography) using data derived from variable-radius inventory[1] plots representing competitive interactions between trees of different species, size and vigour to project growth over a 32-year period. Diameter increment is predicted for tree cohorts based on their species, size and vigour. Every cohort is subjected to a normally distributed random growth fluctuation each year, and predicted regeneration varies randomly within limits defined by canopy opening and pre-harvest species composition. It is notable that the minor stochastic annual growth variation can make a substantial difference to financial values and product outputs in 30 years. This observation suggests that silvicultural experiments in mixed forest will be highly sensitive to initial condition and site, making it difficult to establish conventional experimental treatment and control plots Variability characteristic of these forests means that many replicates are needed to provide informative data for parameters other than non-specific attributes such as average stand basal area or gross biomass.

[1] Variable radius (or plotless) inventory is a sampling method which selects trees with probability proportional to size, usually by selecting trees with diameter larger than a critical angle (e.g. defined by a gauge held at arms length), when viewed from the sampling point. The method is commonly used to estimate stand basal area (West 2004).

In simulations of the 21 case studies, differences between interventions are most obvious in the distribution of size and vigour of the forest stand, rather than in species composition, groundcover, understorey or litter. The analysis indicates that stands which are in poor silvicultural condition can only be restored to their productive potential over a very long period of time (considerably more than 30 years), or by heavy culling or gap creation (Jay 2006b). In the absence of intervention, most of the simulated forest stands were predicted to have a declining commercial component. Unfortunately, the investment cost of adequate treatment in most stands (in the order of a few hundred dollars per hectare) would not be repaid by increases in net stumpage value, assuming real (i.e., net of inflation) discount rates of 3% or more and a 30-year time horizon.

## Private Forest Regulations in NSW

The private native forest estate in north-east NSW is characterised by

- stands with few large trees and many small (<40 cm dbh), suppressed or non-merchantable trees;
- stands in which past high-grading has created a forest in which uneconomic to undertake thinning or culling[2] to improve stand condition is not financially justified;
- stands with high habitat values, irrespective of logging history; and
- landscapes that are heterogeneous with respect to landholder objectives and forest structure.

Given this scenario, it would seem desirable to encourage silviculture to improve productivity while creating or retaining rare habitats on larger land parcels, whilst allowing the majority of landowners to pursue their own objectives and 'quiet enjoyment'[3] of their land without hindrance.

In the Australian federation, land-use planning controls, including forest management, are the responsibility of State governments. In many jurisdictions around the world, both public and private forests are managed in accordance with codes of forest practice in which the most common primary aim is to ensure sustainable timber production (Turnbull and Vanclay 1999). In NSW, timber harvesting (and other activities) defined by the NVA as private native forestry does not require regulatory approval provided it is (i) 'sustainable', (ii) does not encompass State Protected Land (mainly slopes of greater than 18°), (iii) does not have a significant impact on listed fauna or flora species, and (iv) is allowable under local Council plans. A perceived need to regulate NSW private forestry apparently arose from concerns that (i) the 'sustainable forestry' exemption was being abused as a means of permanent (partial) land clearing, (ii) no statistics were available for the extent or nature of forestry practices on private land, (iii) rates of harvest may be

[2] 'Culling' as used here, implies that a tree is defective and could be removed or killed to gain a silvicultural (& economic) benefit regardless of whether the stand is 'overstocked'.

[3] 'Quiet enjoyment' is a common law right implied automatically in title and lease.

exceeding the sustainable yield, and (iv) soil erosion, water pollution and habitat loss were a substantial risk with prevailing practices (Prest 2004). To allay these concerns a Draft Code of Practice for Private Native Forestry was introduced in July 2006, which sought to remove the 'sustainable forestry' exemption and apply a number of conditions to forest management (Nichols 2007).

These conditions would have obliged the landowner to prepare written forest management and harvest plans with maps, notify the Department of Natural Resources (DNR) of harvest intent and report post-harvest volumes and areas and silvicultural treatment methods, establish exclusion zones of 10–40 m width each side of all mapped watercourses, retain prescribed amounts of basal area (from 12 to 18 $m^2$/ha depending on forest type and tree height), limit canopy gap openings width to a maximum of twice the mature tree height and 20% of the total forest area on the property, retain a minimum of 10 hollow-bearing trees and recruits per hectare in the logging area, and comply with various other prescribed conditions. In return, the DNR would guarantee a right to harvest in compliance with the Code for a period not exceeding 15 years, as registered on a legal instrument known as a Property Vegetation Plan. All commercial harvest, even of a single tree, would have to meet these requirements. However, the draft Code did not provide evidence that these perceived abuses were occurring, nor any scientific rationale or support for the various prescriptions. These prescriptions appear to be mainly a means of creating a quantitative (and thus legally enforceable) limit whereby regulators can be satisfied that landowners are meeting the statutory obligation of the *Native Vegetation Act 2003* to 'maintain or improve environmental outcomes'.

## Conclusion

Removal of competing non-commercial trees in structurally degraded stands is essential to restore timber production potential in north–east NSW sclerophyll forests. However, some trees that could potentially be removed to stimulate forest growth may have contributed to wildlife habitat. Policy mechanisms including financial compensation that will offset the opportunity costs of maintaining stands with suppressed regrowth and large trees in the overstorey are neeeded to encourage landowners to maintain non-commercial trees for wildlife habitat purposes. Given the relatively low rate of return from timber production, financial incentives may also be required to encourage investments in thinning. A net social and economic gain from such public expenditures is only achieved if there is commensurate gain in habitat values or other public benefits. Opportunity costs for particular stands can be estimated using a simulation modelling approach. When combined with schemes using landowner tenders for providing environmental services, as described by Stoneham et al. (2003), beneficial outcomes can be obtained in an efficient, equitable and effective manner.

The social and ecological diversity within the northern rivers region of NSW conspire to make land-use controversy inevitable. The Regional Forest Agreements raised and dashed the hopes and aspirations of many stakeholders of both production and preservation viewpoints. Thus it is not surprising that views about

regulation of private native forestry are strongly held. Sadly, the views expressed by stakeholders are not always supported by evidence, and it seems that many views are shaped by the local physical appearance of the forest in the short term, rather than an understanding of the ecological dynamics within a broader landscape and longer timeframe. It is hoped that papers in this special issue of *Small-scale Forestry* will contribute towards a more informed debate.

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